IMPACTS OF HARVESTING NATURAL STANDS ON FUNCTIONS OF SOUTHERN BOTTOMLAND HARDWOOD FORESTS, U.S.A.

John A. Stanturf

Project Leader, Center for Bottomland Hardwood Research, USDA Forest Service, P.O. Box 227, Stoneville, MS 38776 USA

B. Graeme Lockaby

Professor, Department of Forestry, Auburn University, Auburn, AL 36849

Michael G. Messina

Professor, Department of Forest Science, Texas A&M University, College Station TX 77843

INTRODUCTION

Riverine systems are the most extensive forested wetlands in the United States, occupying as much as 13 million ha (Sharitz and Mitsch 1993). Riverine forests are hydrologically connected with other parts of the landscape. Forest management activities that alter the biogeochemical transformations occurring within riverine wetland forests can influence a much larger portion of the landscape and aquatic ecosystems (Brinson 1993).

Floodplains of southern rivers typically are occupied by a mosaic of vegetation communities that are defined by hydroperiod (Shelford 1954, Hodges in press). Areas such as deepwater may be dominated by *Nyssa aquatica* and *Taxodium distichum*. Active floodplains exhibit a broader range of species composition. The wetter portions of active floodplains may be occupied by *Magnolia virginiana, Quercus lyrata, Acer rubrum, Carya aquatica*, and *Q.hemisphaerica*. Moderately well-drained soils support *Liquidambar styraciflua* and *Q.nigra* , while *Q.pagoda* and *Nyssa sylvatica* often occur on better drained sites such as old terraces (Sharitz and Mitsch 1993, Hodges In press). Although deciduous angiosperms dominate these forests, gymnosperms such as *Pinus elliotti, P. glabra, and P. taeda* can be common.

Floodplain communities in the southern United States are among the most productive forests of the temperate zone. Nutrient cycling of the annual litterfall, estimated to range between 3 t ha^{-1} and 7 t ha^{-1}, is rapid. Total aboveground biomass production ranges between 7 t ha^{-1} and 20 t ha^{-1} (Brinson 1990, Conner 1994).

Human activities since European settlement have drastically affected the current condition of almost all floodplain forests in the southeastern United States (Wharton 1978, Kellison and Young, in press). The nature and intensity of these activities varied widely, and sometimes included clearing for agriculture (Williams 1989, Kellison and Young in press). For example, the spatial pattern of species occurrence today in some floodplain forests of the Atlantic coastal plain reflects altered hydroperiods due to 19th and early 20th century agricultural drainage or diking for flooded rice culture (Lockaby et al.In press b, Kellison and Young In press). Less accessible or wetter floodplains were logged even if uncultivated. Usually, exploitive logging removed only larger trees of valuable species such as *Taxodium, Quercus,* or *Pinus.* Logs were removed using animals, spur railroads, and within the wettest areas, pull boats (Walker 1991, Williams 1989).

in habitat (Pechmann et al. 1989), have small home ranges (Corn and Bury 1989), and many species occupy terrestrial-aquatic ecotones. In a minor bottom floodplain, Clawson et al. (in press) found that density was affected only marginally but that diversity declined sharply immediately after helicopter harvests. However, diversity recovered by six months after harvests, presumably as vegetative cover was reestablished and surface soil temperatures began to return to pre-harvest ranges. Although the number of species recovered, shifts in species composition persisted during the two-year study. Phelps and Lancia (1992, Perison et al. in press), working in the coastal plain of South Carolina reported greater diversity in clear-cut areas although no statistical differences existed between clearcuts and controls. As in the case of vegetative responses, the time required for re-establishment of pre-harvest amphibian populations (or the degree to which re-establishment may occur at all) is unknown.

LITERATURE CITED

Aust, W. M. and Lea, R. 1991. Soil temperature and organic matter in a disturbed forested wetland. *Soil Science Society of American Journal* 55:1741-1746.

Aust, W. M. and Lea, R. 1992. Comparative effects of aerial and ground based logging on soil properties in a tupelo-cypress wetland. *Forest Ecology and Management* 50:57-73.

Aust, W. M., Schoenholtz, S. H., Zaebst, T. W., and Szabo, B. A. in press. Recovery status of a tupelo-cypress wetland seven years after disturbance: Silvicultural implications. *Forest Ecology and Management.*

Barry, J. E. and Nix, L. E. 1992. Impact of harvesting activities on oak seedling establishment in a bottomland hardwood forest. In: J. C. Brissette (Editor) Proc. of 7th Biennial Southern Silvicultural Research Conference Gen. Tech. Rep. SO-93, Asheville, NC. U. S. Department of Agriculture, Forest Service, p. 155-159.

Brinson, M. M. 1990. Riverine forests. In: Ecosystems of the World 15:Forested Wetlands. Elsevier. New York. 527 pp.

Brinson, M. M. 1993. Changes in the functioning of wetlands along an environmental gradient. *Wetlands.* 13:65-74.

Clawson, R. G., Lockaby, B. G. and Jones, R. H. in press. Amphibian responses to helicopter harvesting in forested floodplains of low order, blackwater streams. *Forest Ecology and Management.*

Conner, W. H. 1994. Effect of forest management practices on southern forested wetland productivity. *Wetlands* 14(1):17-40.

Corn, P. S. and Bury, R. B. 1989. Logging in western Oregon: Responses of headwater habitats and stream amphibians. *Forest Ecology and Management* 29:39-57.

Elder, J. F. 1985. Nitrogen and phosphorus specification and flux in a large river system. *Water Resources Research* 21:724-732.

Hart, C. P., Hodges, J. D., Belli, K., and Stanturf, J. A. 1995. Evaluating potential oak and ash regeneration on minor bottoms in the Southeast. In: M. B. Edwards (compiler) Proc. 8th Biennial Southern Silvicultural Research Conference; 1994 Nov. 1-3; Auburn, AL. Gen. Tech. Rep. SRS-1,

Asheville, NC: U. S. Dept. Agric., Forest Service, p.434-442.

Haywood, J. D. and Tiarks, A. E. 1995. Growth reductions in short-rotation loblolly and slash pines in central Louisiana - 10th year results. In: M. B. Edwards (compiler) Proc. 8th Biennial Southern Silvicultural Research Conference; 1994 Nov. 1-3; Auburn, AL. Gen. Tech. Rep. SRS-1, Asheville, NC: U. S. Dept. Agric., Forest Service, p.268-274.

Hodges, J. D. in press. Development and ecology of bottomland hardwood sites. *Forest Ecology and Management.*

Kellison, R. C. and Young, M. J. in press. The bottomland hardwood forests of the southern United States. *Forest Ecology and Management.*

Lloyd, S. 1995. Woody regeneration following helicopter and skidder harvest of narrow, branch-bottom wetlands in south Alabama. M.S. Thesis. Auburn University.

Lockaby, B. G., Thornton, F. C., Jones, R. H., and Clawson, R. G. 1994. Ecological responses of an oligotrophic floodplain forest to harvesting. *Journal of Environmental Quality* 23:901-906.

Lockaby, B.G., Jones, R.H., Clawson, R.G., Meadows, J.S., Stanturf, J.A. and Thornton, F.C. in press a. Effects of harvests in forested floodplains of low order streams in Alabama. *Forest Ecology and Management.* In press.

Lockaby, G., Clawson, R.G., Flynn, K., Rummer, R.B., Meadows, J.S., Stokes, B.J., and Stanturf, J. in press b. Influence of harvesting on biogeochemical exchange in sheetflow and soil processes in an eutropic floodplain forest. *Forest Ecology and Management.* In press.

Mader, S.F., Aust, W.M., and Lea, R. 1988. Changes in net primary productivity and cellulose decomposition rates in a water tupelo-baldcypress swamp following timber harvest. In: J.H. Miller (Editor). Proc. of 5th Biennial Southern Silvicultural Research Conference, Gen. Tech. Rep. SO-74. Asheville, NC. U.S. Dept. Agric., Forest Service: p. 539-543.

Meadows, J.S. and Stanturf, J.A. in press. Silvicultural systems for southern bottomland hardwood forests. *Forest Ecology and Management.*

Messina, M.G., Schoenholtz, S.H., Lowe, M.W., Wang, Z. Gunter, D.K., and Londo, A.J. in press. Initial responses of woody vegetation, water quality, and soils to harvesting intensity in a Texas bottomland ecosystem. *Forest Ecology and Management.*

Pechmann, J.H.K., Scott, D.E., Gibbons, J.W., and Semlitsch, R.L. 1989. Influence of wetland hydroperiod on diversity and abundance of metamorphosing juvenile amphibians. *Wetlands Ecology and Management* 1:3-11.

Perison, D., Phelps, J., Pavel, C. and Kellison, R. in press. The effects of timber harvest in a South Carolina blackwater bottomland. *Forest Ecology and Management.*

Phelps, J.P. and Lancia, R. 1992. Effect of timber harvest on the herpetofauna community of a bottomland hardwood forest. In: J.C. Brissette (Editor). Proc. 7th Biennial Southern Silviculture Research Conference; 1994 Nov. 1-3; Auburn, AL. Gen. Tech. Rep. SO-93, Asheville, NC: U.S. Dept. Agric., Forest Service, p. 151-154.

Rummer, R.B., Stokes, B.J., and Lockaby, B.G. in press. Sedimentation associated with forest road surfacing in a bottomland hardwood ecosystem. *Forest Ecology and Management.*

Scott, M.L., Kleiss, B.A., Patrick, W.J. and Segelquist, C.A. 1990. The effects of development activities on water quality functions of bottomland hardwood ecosystems: the report of the water quality workgroup. In: J.G. Gosselink, L.C. Lee, and T.A. Muir (Editors) Ecological Processes and Cumulative Impacts. Lewis Publishers, Chelsea, MI. Pp. 411-454.

Sharitz, R.R. and Mitsch, W.J. 1993. Southern floodplain forests. In: W.H. Martin, S.G. Boyce, and A.C. Echternacht (Editors) Biodiversity of the Southeastern United States: Lowland Terrestrial Communities. John Wiley and Sons, Inc. New York. 502 pp.

Shelford, V.E. 1954. Some lower Mississippi Valley floodplain biotic communities; their age and elevation. Ecology 35:126-142.

Shepard, J.P. 1994. Effects of forest management on surface water quality in wetland forests. *Wetlands* 14(1):18-26.

Stokes, B.J. and Schilling, A. in press. Improved harvesting systems for wet sites. *Forest Ecology and Management.*

Vitt, L.J. Caldwell, J.P., Wilbur, H.M., and Smith, D.C. 1990 Amphibians as harbingers of decay. *Bioscience* 40:418.

Walbridge, M.R. and Lockaby, B.G. 1994. Effects of forest management on biogeochemical functions in southern forested wetlands. *Wetlands.* 14(1):10-17.

Walker, L.C. 1991. The Southern Forest: A Chronicle. Univ. of Texas Press, Austin. 322 pp.

Wharton, C.H. 1978. The Natural Environments of Georgia. Georgia Dept. of Natural Resources, Atlanta, GA. 227 pp.

Will, G.M., Hodgkiss, P.D., and Madgwick, H.A.I. 1983. Nutrient losses from litterbags containing Pinus radiata litter: Influences of thinning, clearfelling, and urea fertilizer. *New Zealand Journal of Forestry* Science 13(3):291-304.

Williams, M. 1989. Americans and their forests. Cambridge University Press, New York. 599 pp.

SUMMARY

Southern floodplain forests have been harvested formerly 200 years. Only in the last ten years, however, has information become available about the effects of harvesting on ecological functions. This paper briefly summarizes on-going studies of harvesting impacts in bottomland hardwood ecosystems in the southern United States. There is no evidence from studies to date that harvesting followed by natural regeneration represents a threat to ground or surface water quality, as long as Best Management Practices are followed. Short-term vegetation productivity is similar to that observed prior to harvests. During the early stages of stand development, tree species composition is influenced by harvesting method, especially between ground-based (conventional or wide-tired skidders) and aerial systems (helicopters). Amphibian populations seem to rebound rapidly following harvests, although